LA-UR-22-20928

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Title:	Local Time-Stepping: Matching Temporal Resolution to Spatial Resolution Highlight for LANL Institutional Computing
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Intended for:	Report
Issued:	2022-02-03

Local Time-Stepping: Matching Temporal Resolution to Spatial Resolution

Objective

- Develop an efficient parallel implementation and assess the performance of local time-stepping (LTS) schemes for the shallow water equations in the Model for Prediction Across Scales (MPAS).

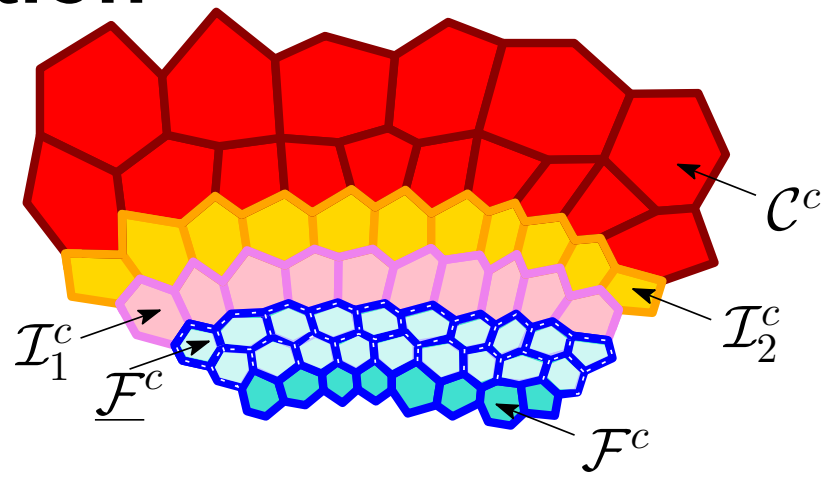
Approach

- Reformulate the LTS schemes to improve their computational performance while minimizing storage requirements.
- Use comparison with other established time-stepping schemes to validate the correctness of the implementation.
- Document the performance and computational timings of the LTS methods with respect to the state-of-the-art time integrator for the MPAS shallow water core.

Impact

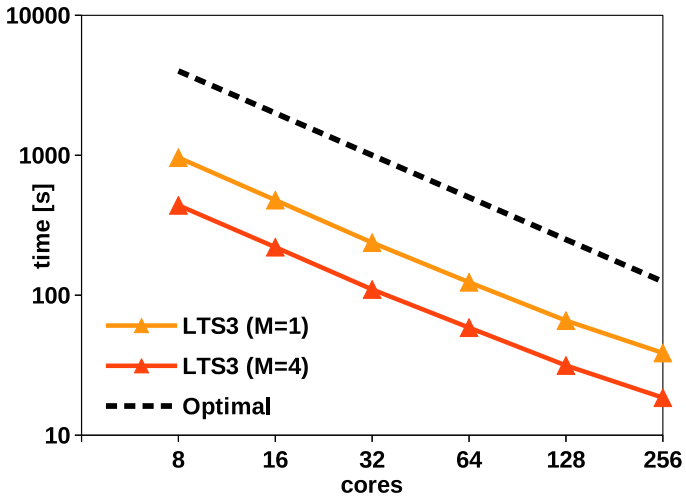
- It allows for faster simulations on existing variable-resolution meshes characterized by relatively few very high-resolution cells.
- The LTS capability improves the spatial resolution of existing variable-resolution meshes in localized areas.

Capodaglio G. and M. Petersen, "Local time stepping for the shallow water equations in MPAS," *J. Comput. Phys.*, **449,** 110818, (2022). [DOI: 10.1016/j.jcp.2021.110818].



(Top) A diagram representing the different time-steps used on different regions of the computational grid. Blue region: fine time-step. All other regions: coarse time-step. (Bottom) The scalability of the LTS scheme is close to linear, only slightly worsening as the number of cores becomes large.

Parallel scalability test



The order three LTS scheme can produce a CPU time savings of 70 percent for certain variable res meshes.